Ground Motion Simulations for the Dunedin-Mosgiel Area

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Overview and objectives

We present our on-going QuakeCoRE-funded work focusing on ground motion simulations for the Dunedin and Mosgiel area. We are aiming for physics-based ground motion simulations – Graves–Pitarka method. Source modelling and ground motion simulations are being carried out using the Southern California Earthquake Center Broadband Simulation Platform (SCEC BBP) and site effect modeling using finite element OpenSees software. The Project focuses on low seismicity area, where big earthquakes have not been experienced in time period of instrumental and historical records.

2 sources and 2 sites

The sources considered include local **Akatore Fault**, along with the more regional **Hyde Fault (Figure 1)**. Both faults show activity based on recent paleoseimic studies (Griffin in prep., Briar et al., 2020).

Two 2D sites defined are named **StBeach** and **Taieri Basin** lines (Figure 2). **StBeach** line goes along the sea in South Dunedin. The geology of this part of Dunedin is characterized by soft alluvial sediments which are prone to ground motion amplification. Site investigations have provided valuable data to constrain the basin model for South Dunedin. The **Taieri** line crosses Taieri basin, which is a tectonic depression located 6 km west from Dunedin and represents the most distinct sedimentary basin in the area.

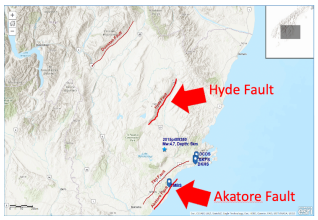

Figure 1: Sources selected for the study: local Akatore and regional Hyde Fault.

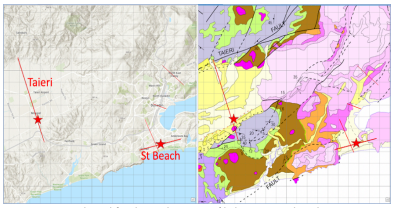

Figure 2: Sites selected for the study. Two profile lines: StBeach and Taieri . Stars show 1D ground motion simulation site locations.Topography map to the left and Qmap to the right.

Soil Column and mesh definition

The soil column for OpenSees site analysis was defined based on available data. Quadriterial Mesh geometry for 2D modelling was created using Gmesh software.

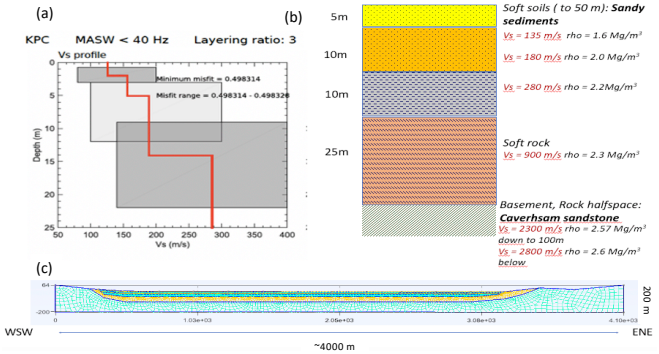

Figure 3: Soil column and mesh geometry for 2D site analysis – StBeach line. (a) Most representative Multichannel Analysis of Surface Waves (MASW) inversion based on the soil profile down to 25 m. (b) Soil column for the analysis. (c) Mesh geometry of the 2D line.

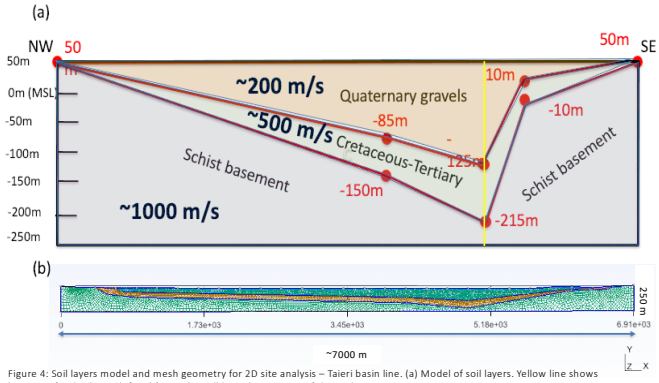

Figure 4: Soil layers model and mesh geometry for 2D site analysis – Taieri basin line. (a) Model of soil layers. Yellow line shows location of soil column defined for analysis. (b) Mesh geometry of the 2D line.

Ground Motion Simulations Results Examples

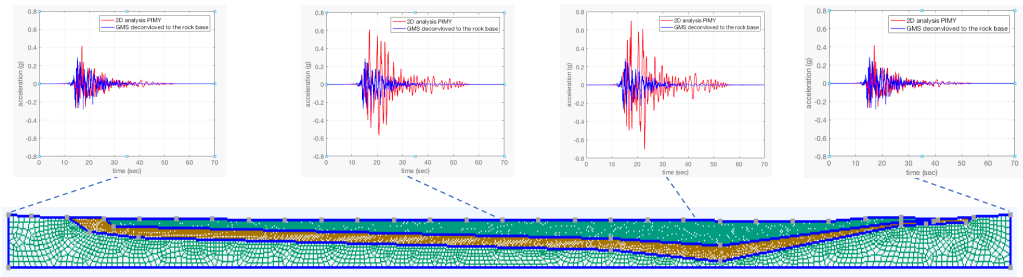

Figure 5 : PGA for selected nodes located on the surface along Taieri Basin 2D line. Ground motions deconvolved to the rock (blue) versus 2D site site analysis using PIMY material for soil layers (red). The simulatons run for Akatore Fault source.

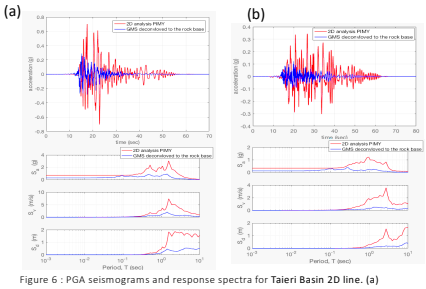

Figure 6 : PGA seismograms and response spectra for **Taieri Basin 2D line. (a)** Akatore Fault source (~20 km from the site), (b) Hyde Fault source (~50 km from the site). Recorder for one node on the surface.

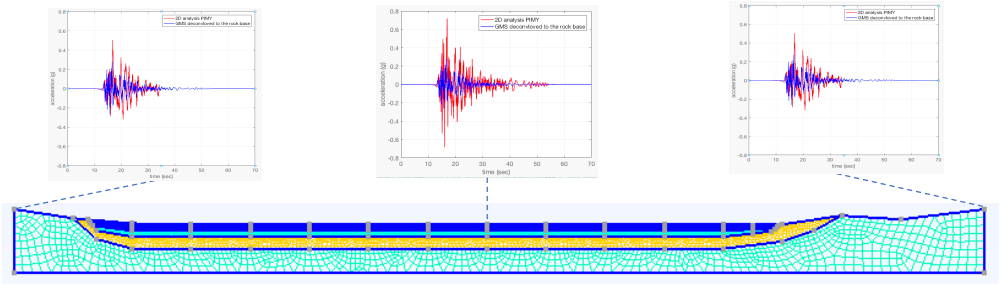

Figure 7 : PGA for selected nodes located on the surface along StBeach 2D line. **Ground motions deconvolved to the rock (blue) versus 2D site site analysis using PIMY material for soil layers (red).** The simulatons run for Akatore Fault source.

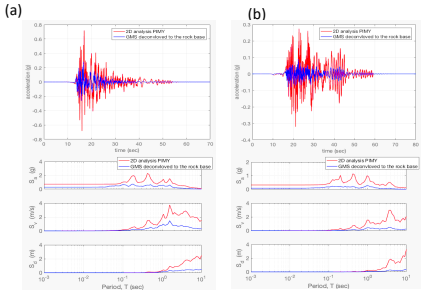

Figure 8 : PGA seismograms and response spectra for**StBeach 2D line. (a)** Akatore Fault source (~20 km from the site), (b) Hyde Fault source (~50 km from the site). Recorder for one node on the surface.

Next steps and future challenges

- Modelling approaches finalization
- Stress/strain nonlinearity evaluation
- Validation
- *There is a great need for future work beyond the scope of this project in the area, including both field investigation and modelling*

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References:

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